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NATURAL MOUNDS

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Recently the subject of natural mounds has attracted unusual attention, and a number of persons have described their occurrence and attempted an explanation of their origin.

What are here designated as natural mounds are low, broad mounds, varying from 10 to 140 feet in diameter, and from a few inches to 5 or 6 feet in height. They are wonderfully symmetrical, both in plan and in elevation, and generally they closely approach a circle in outline, but in places they are slightly elliptical, and where such is the case the major axes of all mounds in the vicinity have a common direction.

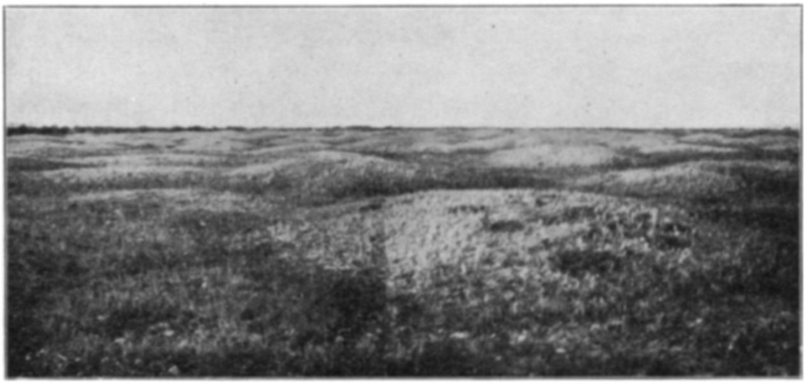

FIG. 1.—Group of natural mounds on old sea terrace back of San Diego, Cal.

Figure 1 is reproduced from a photograph of a group of slightly elliptical mounds occurring on the old sea terrace back of San Diego, Cal., at an altitude of about 380 feet. Frequently the mounds are closely bunched, as shown in the figure, but they occur also singly and in small groups.

According to the descriptions of various writers, the composition of the mounds vary considerably, probably being affected by the character of the local material. As the writer has observed them in California and in Arkansas, they are made up of clay, or clay with a slight admixture of gravel, depending upon the character of the underlying subsoil; but in Texas and Louisiana, according to report, they are made up largely of sand, and in Missouri of chert fragments from the Carboniferous limestones.

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So far as the writer has observed or has been able to obtain references to them, mounds of a similar character occur in abundance in Louisiana, Texas, Arkansas, Missouri, Kansas, Indian Territory, Arizona, California, Oregon, Washington, Mexico, and Argentine Republic.[1] Generally they are reported as occurring on low, flat lands; but Turner[2] has described and figured similar topographic features covering low hills on the east side of the San Joaquin valley in California, and recently Hill[3] has noted their occurrence on the high plateau of Mexico, nearly 7,000 feet above sea-level.

To account for the origin of these mounds various hypotheses have been advanced, but in most cases they are speculative only and have little or no foundation in fact, or they are based upon limited observations and fit only the conditions prevailing in one locality.

It is altogether probable that the mounds which have been noted in various parts of the country are not exactly similar and have not had a common origin, but this cannot be proven until they have been more carefully studied, and studied by one person who can compare the mounds in different localities and judge whether or not they are all due to the same cause.

The principal hypotheses may be summed up as follows:

1. Human agency.
2. Animal burrows, such as ground squirrels, gophers, and prairie dogs.
3. Ant hills.
4. Water erosion.

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[1] Since the above was written the writer has observed similar mounds on the broad flat valley bottom near Logan, Utah.

[2] H. W. Turner, "Further Contributions to the Geology of the Sierra Nevada," U. S. Geological Survey, *Annual Report*, Part 1, pp. 681–83, Plate 33.

[3] R. T. Hill, "On the Origin of the Small Mounds of the Lower Mississippi Valley and Texas," *Science*, N. S., Vol. XXIII, No. 592 (May 4, 1906), pp. 704–6.

5. Chemical solution.
6. Wind action.
7. Physical or chemical segregation.
8. Glacial action.
9. Uprooted trees.
10. Spring and gas vents.
11. Fish nests.

From the widespread distribution of the mounds it is evident that, if they have a common mode of origin, this mode of origin must be such that it will fit a variety of climatic, geologic, and topographic conditions. On this basis it is easy to rule out as general causes a number of the above hypotheses without discussing them in detail. For instance, on the sea terrace back of San Diego, Cal., where the mounds are beautifully developed, or on the prairies south of Tacoma, Wash., the hypothesis which attributes their origin to fish nests might be applicable, for those localities have in recent geologic time been under water; but certainly it would not be applicable to the mounds which occur in other parts of the country. The spring and gas-vent hypothesis might fit the conditions prevailing in Louisiana or Texas, but mounds are just as abundant in areas in which neither of these agencies has acted. It is evident, therefore, that this hypothesis cannot have a broad application, and consequently may be eliminated. The mounds resulting from uprooted trees have been cited as analogous to the mound in question, but such a hypothesis would never have been advocated by a person thoroughly familiar with the mounds in their best development. We should be obliged to presuppose the existence of giant sequoias over the low arid region of southern California and Arizona, and over the moist humid prairie of Texas and Louisiana. Manifestly this is absurd and may be disregarded. Glacial action might be appealed to in explanation of the mounds of Washington, but evidently is not applicable to the great number of mounds found in southern California and the Mississippi valley.

By this method of elimination the number of hypotheses has been reduced to seven, but these seven have a far greater degree of probability, and hence will have to be considered in detail before they are discarded.

The hypothesis of physical or chemical segregation was proposed by Branner,[1] but absolutely no evidence was advanced in support of it. He says:

> One other theory has been in my own mind for several years, but it is almost entirely without observations to support it, and it is perhaps too vague to be clearly expressed. The idea is that in solutions of certain kinds, long exposed to weathering agencies, chemical reactions possibly take place around centers that result in the transfer of minerals in solution, and the precipitation in nuclei that are now represented by the position of the mounds, while the withdrawal of these minerals from the intervening areas causes the depression around the mounds.

Purdue[2] found himself at a loss to account for similar mounds in the Arkansas valley, and took refuge behind Branner's vague hypothesis, but he likewise failed to produce any direct evidence to substantiate it. Manifestly in the present stage of our knowledge this hypothesis has no support, and, until such evidence is presented, it need not be considered.

The question of wind action is not so easily disposed of; doubtless many mounds have been produced by such action, and probably many others of an entirely different origin have been modified by the action of the wind. Nevertheless the great number of natural mounds are far too symmetrical in profile and in plan to have been formed by wind-blown material. Usually it is supposed that dunes may be recognized by their unsymmetrical shape, while the mounds are noted for their symmetry; consequently the only resort was to suppose that they are the result of wind acting in various directions. It is possible to conceive that fine, dry material may be heaped up by winds blowing first from one direction and then from another, producing a measure of symmetry; but when one considers the vast territory over which these mounds occur both in dry and in humid climates, it is evident that such special conditions could not have prevailed, and thus we are forced to drop this hypothesis.

We are thus reduced to five hypotheses, but, since No. 2 and No. 3 are essentially the same as far as the mode of origin is concerned, we may say that the choice lies among four hypotheses: animal burrows, erosion, solution, and human construction. These hypotheses involve two fundamentally different processes, construction and destruction, and it seems possible to determine definitely which of these processes has taken place.

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[1] J. C. Branner, "Natural Mounds or 'Hogwallows,'" *Science*, N. S. Vol. XXI, No. 535 (March 31, 1905), pp. 514–16.

[2] A. N. Purdue, "Concerning the Natural Mounds," *Science*, N. S., Vol. XXI, No. 543 (May 26, 1906), pp. 823, 824.

Many writers have argued that the mounds are the result of erosion, but in most cases they have realized that under normal conditions such forms could not have been produced, and hence they have been compelled to assume unusual conditions, but rarely have they stated clearly what were the unusual conditions.

Practically all of the mounds observed by the writer are located on smooth surfaces, and generally on level plains. Where the mounds are close together they may touch and the slope of one merge into the slope of its neighbor, forming a concave surface; but where mounds are scattering, the space between is always *flat*, being in reality a part of the surface of the plain. In arguing for erosion this fact has generally been neglected, or it has been assumed that the inter-mound surface is not a plain. Thus Barnes,[1] in describing the mounds at San Diego, illustrated in Fig. 1, gives a profile showing the mounds separated by a concave surface. The mounds in this locality were examined very carefully by the writer, and in every case where they were not in actual contact the space between them is flat and not concave, as represented in Barnes's profile. It therefore seems that much of the misapprehension regarding the origin of the mounds is due to imperfect observations and assumptions that are not warranted.

When one considers the way in which surfaces are eroded, it is manifestly impossible to produce a flat surface unless that surface is at base-level, or the process of erosion is controlled by a barrier or by underlying hard rocks. If the surface was at base-level, and the plain a base-level plain, it would mean that the cycle of erosion was practically complete, and in that event the mounds would be reduced as well as other portions of the surface, unless in some abnormal way the mounds were protected from the action of erosion. In order to protect mounds with such symmetrical, spherical surfaces, one would have to suppose a circular segregation of hard material, which certainly would call for unusual conditions. It is true that analogous topographic forms have been produced by such conditions as shown by Gilbert and Gulliver[1] as existing in the Tepee buttes of eastern Colorado. In that case the symmetrical form is due to the protective influence of a calcareous core, which is supposed to have been of fossil origin. In the case of the mounds, however, no one has reported any protective material, except in a few cases where gravel has been noted in more abundance in the mounds than elsewhere. Gravel might answer as a protective cap, but such accumulations are not universal, for in hundreds of cases observed by the writer in Arkansas no gravel is to be found, either in the mounds or in the soil in the vicinity.

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[1] G. W. Barnes, "The Hillocks or Mound-Formations of San Diego, California," *American Naturalist*, Vol. XIII (September, 1879), pp. 565–71.

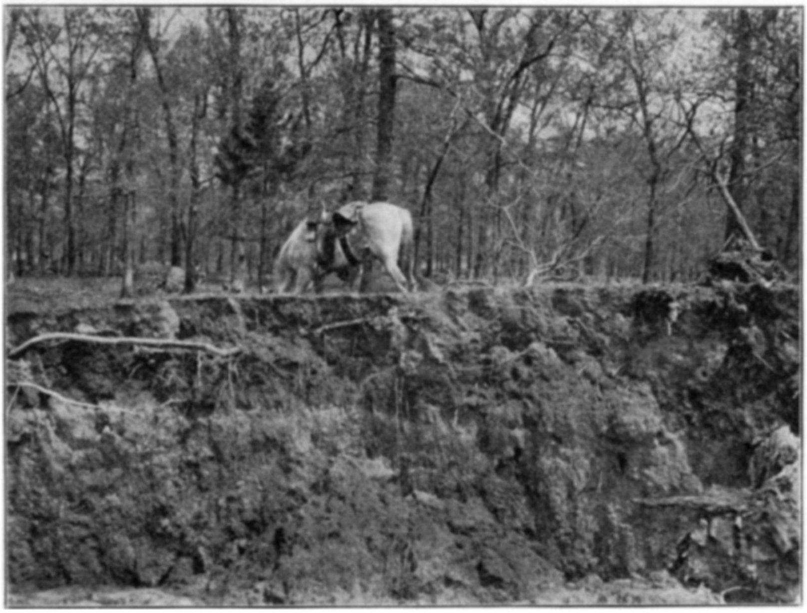

FIG. 2.–Section of a mound 3 miles northwest of Dardanelle, Ark., showing that the material composing the mound is of different color and texture from the underlying subsoil.

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[1] G. K. Gilbert and F. P. Gulliver, "Tepee Buttes," Geological Society of America, *Bulletin*, Vol. VI pp. 333–42, Plate 17.

Although the evidence given above seems to show conclusively that mounds are not the result of erosion nor of solution, the writer is able to produce more positive evidence that will appeal to everyone, whether he is familiar with the processes of erosion or not.

During the month of April, 1906, the writer had an opportunity to observe thousands of mounds in the valley of the Arkansas between Little Rock and Fort Smith. They are abundant everywhere on the lowland above the flood-plain of the river, and while many of these have been cut through in grading for railways and highways, it is difficult to find a fresh section in which the structure and composition of the mounds are well shown. At last a mound was found on the Paris road about 3 miles northwest of Dardanelle, Ark., which recently had been dissected by a small stream flowing by the roadside, and a fresh section was exposed. Figure 2 is a photograph of the mound as it appeared in the section.

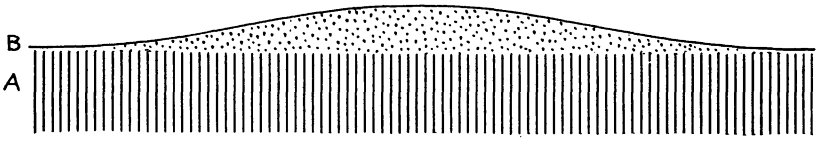

FIG. 3.—Diagrammatic section of mound shown in FIG. 2. *A* is yellowish-white clay. *B* is soil composed of the clay subsoil reworked with the addition of carbonaceous material. Mound same as soil.

The plain upon which the mound appears is flat and composed of a deep subsoil of yellowish-white clay, formed by the decomposition of Carboniferous shale. The clay is homogeneous and structureless, except that it shows a tendency to vertical cleavage in much the same way that such cleavage is shown in loess. At the surface and for a depth of from 6 to 12 inches the clay has been opened up and reworked by grass and tree roots, and a small amount of carbonaceous matter has been incorporated in the clay, giving it a slightly darker color than it had originally.

The mound which had been dissected was approximately circular before it had been cut away, with a diameter of about 60 feet and a height of 4 feet. The diagram in Fig. 3, which is drawn to scale, gives a good idea of the size and shape of the mound as it was seen in profile. The underlying clay subsoil is shown at *A*, the ordinary soil at *B*, and the line separating them was visible as an approximately straight line entirely across the mound. The material composing the mound is essentially like the soil on either side; that is, it is reworked clay, probably derived from the underlying subsoil.

The above section shows clearly that the body of the mound is composed of material exactly like the surrounding soil, which is derived from the underlying clay; and consequently it is a fair inference to suppose that the mound material came from the same source; but, whether this be true or not, the arrangement of the materials proves conclusively that the mound was *built*, and is not a residual left by erosion or solution. Since in this case the evidence is positive that this mound is not the result of erosion, and also since, in the opinion of the writer, the general evidence against such a mode of origin, at least for the mounds of Arkansas and California, is conclusive, the two hypotheses of erosion and solution, as applied to the great multitude of mounds in the southern part of the United States, may be dropped.

The case is now narrowed down to two modes of origin—namely, human construction and the action of burrowing animals.

Although much has been written regarding the human origin of these mounds, the arguments against it are so strong that it may be classed with the other hypotheses which have been disregarded. It is doubtless true that similar mounds have been erected by prehistoric man, but it is absurd to suppose that the countless millions of mounds which exist in the regions noted above have been the result of human activity.

This disposes of all the hypotheses, except that which ascribes their origin to the action of burrowing animals; but whether the mounds are due to ants or to small rodents, the writer is unable to say. Personally he inclines to the ant-hill hypothesis, but there is little or no evidence to determine which is correct. No burrows or chambers of any kind have been discovered in the mounds, and in the case observed by the writer no differences were observed in the character of the underlying clay, which would indicate the former presence of chambers, even though they are now filled. No excavations were noted in the neighborhood which could have supplied outside material for the mound, and consequently it is assumed that this material must have come from a long distance under ground, and the minute channels through which it was transported have been closed by material falling in from above or carried in by water in suspension.

The constructional feature of the mound is considered to have been proved in this particular case, but it still remains to account for the agent that performed the work. It is believed, however, that careful work in trenching some of the best preserved examples of these mounds would furnish some evidence to determine this part of the question, but such investigations have never been undertaken, at least not on an extensive scale.

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